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PRELIMINARY GEOTECHNICAL INVESTIGATION
21-ACRE PARCEL
SOUTHWEST OF KIOWA STREET
AND CUSTER STREET
BENNETT, COLORADO

Prepared For:

PEAK DEVELOPMENT
1150 Delaware Street, #202
Denver, Colorado

Attention: Chad Ellington

Project No. DN50,554-115-R1

July 15, 2020

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SCOPE

This report presents the results of our Preliminary Geotechnical Investigation for the 21-Acre Parcel located southwest of Kiowa Street and Custer Street in Bennett, Colorado (Fig. 1). The purpose of this investigation was to evaluate subsurface conditions and provide preliminary geotechnical design and construction criteria for the project. The scope was described in our Service Agreement (Proposal No. DN 20-0193) dated April 24, 2020. A Phase I Environmental Site Assessment (Project No. DN50,554-200-R1; report dated June 4, 2020) was completed by our firm.

This report is based on conditions found in our exploratory borings, results of field and laboratory tests, engineering analysis of field and laboratory data, previous investigation and our experience with similar conditions. The information was prepared for planning purposes only. Additional investigations will be required to develop foundation design criteria. Other types of construction may require revision of this report and the recommended design criteria. A summary of our conclusions and recommendations follows.

SUMMARY OF CONCLUSIONS

1. Strata found in our borings consisted of silty, sandy clay and silty, clayey sand to the maximum explored depth of 40 feet. Bedrock was not encountered in this investigation. The clay is expansive and compressible. The sand is judged to be non-expansive.

2. Groundwater was not encountered during our investigation. Groundwater levels may fluctuate with seasons and in response to precipitation and landscape irrigation.

3. The presence of expansive and compressible soil constitutes a geologic hazard. There is risk that ground-supported improvements will heave and be damaged. We believe the recommendations presented in this report will help control risk of damage; they will not eliminate the risk.

Slabs-on-grade, and in some instances, foundations may be damaged by swelling and compressible soil.

4. Footing foundations will be appropriate in areas with low swelling or non-expansive soils. Due to the depth of bedrock, deep foundation systems (drilled piers) are likely not feasible for construction in moderate swelling and compressible soils. Alternatively, sub-excavation should allow use of shallow foundations and slab-on-grade floors.

5. Surface drainage should be designed, constructed, and maintained to provide rapid removal of surface runoff away from the buildings and off pavements and flatwork to reduce potential subsurface wetting. Water should not be allowed to pond adjacent to the building or in pavement and flatwork areas.

6. Control of surface and subsurface drainage will be critical to the performance of foundations, slabs-on-grade, pavements and other improvements. Overall surface drainage should be designed to provide rapid runoff of surface water away from structures and off pavements and flatwork. Water should not be allowed to pond near structures or on pavements and flatwork, or on the crests of slopes. Conservative irrigation practices should be employed to reduce the risk of subsurface wetting.

SITE CONDITIONS

The 21-Acre Parcel is located at southwest of Kiowa Street and Custer Street in Bennett, Colorado (Fig. 1 and Photo 1). The site is bordered by residences to the north and west, commercial buildings to the north, and vacant fields to the south and east. Colorado Highway 36 is located approximately 0.1-mile to the north.

The parcel is currently vacant, and the ground is covered with grasses, weeds, and shrubs. Our review of Google Earth historical images indicates the parcel has been solely used for agricultural purposes dating back to 1993. The parcel is relatively flat across the site and slopes slightly to the northeast. Relief across the site is approximately 10 feet in total elevation change.

Photo 1 – Google Earth Aerial Site Photo, June 2016

PROPOSED CONSTRUCTION

Conceptual plans were not available at the time of this report. We anticipate the parcel will utilize asphalt or concrete pavement.

INVESTIGATION

Subsurface conditions were investigated by drilling six exploratory borings the approximate locations shown in Fig. 1. We determined boring locations and elevations using a Leica GS18 GPS unit referencing the North American Vertical Datum of 1988 (NAVD88). Prior to drilling, we contacted the Utility Notification Center of Colorado and local sewer and water districts to identify locations of buried utilities. The borings were advanced to depths of 25 to 40 feet using 4-inch diameter, continuous-flight auger and a truck-mounted CME-45 drill rig. Summary logs of the soils encountered in our borings, field penetration resistance tests, and a portion of laboratory test data are presented in Appendix A.

Samples of the soil were obtained at 5-foot intervals using 2.5-inch diameter (O.D.), modified California barrel samplers driven by blows of a 140-pound automatic hammer falling 30 inches. Our field representative was present during drilling to observe drilling operations, log the strata encountered in the borings and obtain samples for laboratory testing.

Samples were returned to our laboratory where they were examined by our engineers and tests were assigned. Laboratory tests included moisture content and dry density, gradation, percent silt and clay-sized particles (passing No. 200 sieve), Atterberg limits, swell-consolidation, and water-soluble sulfate concentration. Swell-consolidation tests were performed by wetting samples under approximate overburden pressures (the pressure exerted by the overlying soils). Results of laboratory tests are presented in Appendix B and summarized on Table B-I.

SUBSURFACE CONDITIONS

Strata found in our borings consisted of silty, sandy clay and silty, clayey sand to the maximum explored depth of 40 feet. Bedrock was not encountered in this investigation. The clay was stiff to very stiff. The sand was medium dense to very dense. Six soil samples contained 29 to 71 percent silt and clay-sized particles and two clay samples exhibited moderate plasticity. Two samples compressed 4.9 and 7.0 percent, and nine clay samples swelled 0.3 to 3.4 percent when wetted under approximate overburden pressures.

Groundwater not encountered during this investigation. We do not believe groundwater will influence construction. Groundwater levels may fluctuate with seasons and in response to precipitation and landscape irrigation.

Seismicity

The soil is not expected to respond unusually to seismic activity. According to the 2009 International Building Code (IBC) (Standard Penetration Resistance method of Section 1613.5.2), and based upon the results of our investigation, we judge the site classifies as Site Class D. The subsurface conditions indicate nil susceptibility to liquefaction. Only minor damage to relatively new, properly designed and constructed buildings would be expected with a major seismic event. Wind loads typically govern dynamic structural design in this area.

GEOLOGIC HAZARDS

Colorado is a challenging location to practice geotechnical engineering. The climate is relatively dry, and the near-surface soils are typically dry and comparatively stiff. These soils and related sedimentary bedrock formations tend to react to changes in moisture conditions. Some of the soils and bedrock swell as they increase in moisture and are referred to as expansive soils. Other soils can compress significantly upon wetting and are identified as compressible soils. Much of the land available for development east of the Front Range is underlain by expansive clay or claystone bedrock near the surface. The soils that exhibit compressible behavior are more likely west of the Continental Divide; however, both types of soils occur throughout the state. Expansive soils are present on this parcel, which constitutes a geologic hazard. There is risk that foundations and slab-on-grade floors will experience heave or settlement, and damage. Covering the ground with structures, streets, driveways, patios, etc., coupled with lawn irrigation and changing drainage patterns, leads to an increase in subsurface moisture conditions. Thus, some soil movement due to heave or settlement is inevitable. Our investigation indicates there is moderate risk that ground heave will damage improvements at this site. We judge there is a potential heave of up to 3 inches at the ground surface. Due to higher compression numbers, there is also a risk of settlement from compressible soil. The risk of foundation and slab movements can be mitigated, but not eliminated by careful design, construction, and maintenance procedures. We have provided criteria for sub-excavation below the structures and use of footings and slab-on-grade floors.

SITE DEVELOPMENT

The near surface clay soils exhibited low to moderate swell and compress potential. If footings are desired, we recommend sub-excavation to at least 10 feet below the bottom of the slabs (7 feet below footings) and replacement of the excavated soils as moisture treated fill. Structure footprints should be excavated to the same elevation so that a uniform depth of fill is created.

Excavation

We believe the soils encountered in our exploratory borings can be excavated with conventional, heavy-duty excavation equipment. We recommend the owner and the contractor become familiar with applicable local, state and federal safety regulations, including the current OSHA Excavation and Trench Safety Standards. We believe the sand will classify as Type C soil and the clay will classify as Type B soil. Type B and C soils require maximum slope inclinations of 1:1 and 1.5:1 (horizontal:vertical), respectively, for temporary excavations in dry conditions. Flatter slopes will be required below ground water or where seepage is present. The contractor's "competent person" should review excavation conditions and refer to OSHA Standards when worker exposure is anticipated. A Registered Professional Engineer should design excavations greater than 20 feet deep.

Sub-Excavation and Site Grading

Our investigation indicates expansive and compressible clay is present at depths likely to influence the performance of shallow foundations and slabs-on-grade for portions of the site. Sub-excavation may be used to create more stable soil conditions and reduce risk of excessive movements. We can provide an estimated extent of sub-excavation after site grades and finished floor elevations have been determined. Assuming minimal grading is necessary and finished floors are near the existing grades, we preliminarily estimate sub-excavation depths on the order of 5 feet may be necessary. Subsurface conditions are highly variable. It is probable that moderate or higher swelling or compressible soils may be found at depths likely to negatively influence foundations and slab-on-grade floors after sub-excavation and site grading are completed. Additional investigation may be necessary to further delineate horizontal and vertical limits of sub-excavation.

The grading contractor should be chosen carefully to assure they have experience with fill placement at over-optimum moisture and have the necessary compaction equipment. The contractor should provide a construction disc to break down fill materials and anticipate use of push-pull scraper operations and dozer assistance. The operation will be relatively slow. For the procedure to be performed properly, close contractor control of fill placement to specifications is required. Grading and sub-excavation fill should be moisture-conditioned between 1 and 4 percent above optimum moisture content for clay, and within 2 percent of optimum for sand, and compacted to at least 95 percent of maximum standard Proctor dry density (ASTMD698).

Special precautions should be taken for compaction of fill at corners, access ramps, and along the perimeters of the sub-excavation as large compaction equipment cannot easily reach these areas. Our representative should observe placement procedures and test compaction of the fill on a “full-time” basis. The swell of the moisture-conditioned fill should be tested after the fill placement. Guideline grading specifications are presented in Appendix C.

Our experience indicates fill and backfill can settle, even if properly compacted to criteria provide above. Factors that influence the amount of settlement are depth of fill, material type, degree of compaction, amount of wetting and time. The degree of compression of fill under its own weight will likely range from low for granular soils (½ percent or less) to moderate for clay/sand mixtures (1 to 2 percent). Most of this compression should occur quickly after placement.

BUILDING CONSTRUCTION CONSIDERATIONS

The following discussions are preliminary and are not intended for design or construction.

Foundations

Footing foundations may be used for sites where non-expansive and low swelling natural soil is present within depths likely to influence performance of foundations. Where moderate to high swelling or compressible soils are present, sub-excavation should allow use of footing foundations and create low risk conditions for poor performance of slab-on-grade floors on most of the remaining areas. Deep foundation systems (drilled piers) do not appear to be efficient due to the depth of bedrock on the site.

Slab Performance Risk

Slab-on-grade floors may be considered on low and some moderate risk areas on this site where potential heave is acceptable to builders and home buyers. Structurally supported floors should be used on all sites with high or very high risk of poor slab performance. Sub-excavation should reduce potential heave to about 1-inch or less and allow wider use of slab-on-grade floors.

The following precautions will be required to reduce the potential for damage due to movement of slabs-on-grade placed at this site:

1. Isolation of the slabs from foundation walls, columns and other slab penetrations;

2. Voiding of interior partition walls to allow slab movement without transferring the movement to the structure;

3. Flexible water and gas connections to allow slab movement. A flexible plenum above furnaces will be required; and

4. Proper surface grading and foundation drain installation to reduce water availability to sub-slab and foundation soils.

Surface Drainage

The performance of improvements will be influenced by surface drainage. When developing an overall drainage scheme, consideration should be given to drainage around each building. The ground surface around the buildings should be sloped to provide positive drainage away from the foundations. If the distance between buildings is less than 20 feet, the slope in this area should be 10 percent to the swale between buildings. Where possible, drainage swales should slope at least 2 percent; more slope is desirable. Variation from these criteria is acceptable in some areas. We believe it is acceptable to use a slope of about 6 inches in the first 10 feet at this location. Roof downspouts and other water collection systems should discharge beyond the limits of all backfill around structures.

Proper control of surface runoff is also important to control the erosion of surface soils. Concentrated sheet flow should not be directed over unprotected slopes. Water should not be allowed to pond at the crest of slopes. Permanent slopes should be prepared in such a way to reduce erosion.

Attention should be paid to compact the soils behind curb and gutter adjacent to streets and in utility trenches during the development. If surface drainage between preliminary development and construction phases is neglected, performance of the roadways, flatwork and foundations may be poor.

Pavements

The soil properties of the pavement subgrade will affect pavement thickness design and expansive subgrade mitigation. Our investigation indicates pavement subgrade will likely consist primarily of expansive or compressible native clay with lesser amounts of non-expansive sand. Clay soils are considered to have relatively poor pavement support characteristics. In the areas underlain by expansive or compressible materials near the surface, it appears sub-excavation of at least 3 feet below bottom of pavement is likely merited. Deeper sub-excavation may be needed, and expansive soil mitigation beyond moisture-conditioning and compaction may be necessary depending on grading plans and additional geotechnical investigations. Additional measures may be needed to supplement subgrade sub-excavation. Placement of extra base course is one alternative. Chemical stabilization using cement or lime is another. We anticipate about 6 to 7 inches of asphalt pavement for private drives and residential streets or about 3 to 4 inches of asphalt and 8 inches of base course. Design-level subgrade investigations should be performed prior to paving.

CONCRETE

Concrete in contact with soil can be subject to sulfate attack. A water-soluble sulfate concentration of 0.03 to 0.09 percent was measured in two samples from this site. Sulfate concentrations less than 0.1 percent indicate Class 0 exposure to sulfate attack for concrete in contact with the subsoils, according to the American Concrete Institute (ACI). For this level of sulfate concentration, ACI indicates any type of cement can be used for concrete in contact with the subsoils. Superficial damage may occur to the exposed surfaces of highly permeable concrete, even though sulfate levels are relatively low. To control this risk and to resist freeze-thaw deterioration, the water-to-cementitious material ratio should not exceed 0.50 for concrete in contact with soils that are likely to stay moist due to surface drainage. Concrete should have a total air content of 6 percent ± 1.5 percent.

CONSTRUCTION OBSERVATIONS

This report has been prepared for the exclusive use of Peak Development and your design team for the purpose of providing geotechnical design and construction criteria for the 21-Acre Parcel southwest of Kiowa Street and Custer Street. The information, conclusions, and recommendations presented herein are based upon consideration of many factors including, but not limited to, the type of structures proposed, the geologic setting, and the subsurface conditions encountered. Standards of practice evolve in geotechnical engineering. The recommendations provided are appropriate for about three years. If the site is not developed within about three years, we should be contacted to determine if we should update this report.

We recommend that CTL | Thompson, Inc. provide construction observation services to allow us the opportunity to verify whether soil conditions are consistent with those found during this investigation. If others perform these observations, they must accept responsibility to judge whether the recommendations in this report remain appropriate.

GEOTECHNICAL RISK

The concept of risk is an important aspect with any geotechnical evaluation, primarily because the methods used to develop geotechnical recommendations do not comprise an exact science. We never have complete knowledge of subsurface conditions. Our analysis must be tempered with engineering judgment and experience. Therefore, the recommendations presented in any geotechnical evaluation should not be considered risk-free. Our recommendations represent our judgment of those measures that are necessary to increase the chances that the structures and improvements will perform satisfactorily. It is critical that all recommendations in this report are followed during construction. Owners or property managers must assume responsibility for maintaining the structures and use appropriate practices regarding drainage and landscaping. Improvements after construction should be completed in accordance with recommendations provided in this report and may require additional soil investigation and consultation.

LIMITATIONS

Our borings were spaced to obtain a reasonably accurate picture of subsurface conditions below the proposed development. The borings are representative of conditions encountered only at the location drilled. Subsurface variations not indicated by our borings are possible.

We believe this investigation was conducted in a manner consistent with that level of care and skill ordinarily used by geotechnical engineers practicing in this area at this time. No warranty, express or implied, is made. If we can be of further service in discussing the contents of this report, or in the analysis of the influence of the subsurface conditions on the design of the building or any other aspect of the proposed construction, please call.

CTL | THOMPSON, INC.

Sam Rumel
Staff Engineer

Reviewed by:

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Alan J. Lisowy, P.E.
Principal Engineer

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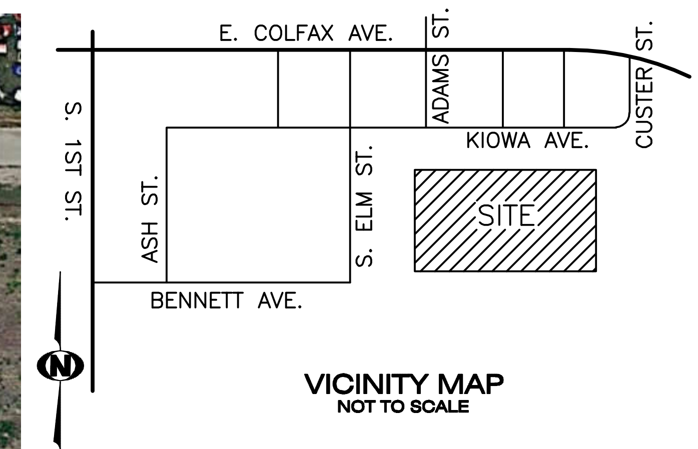
Jul 15 2020

SR:AJL/nn

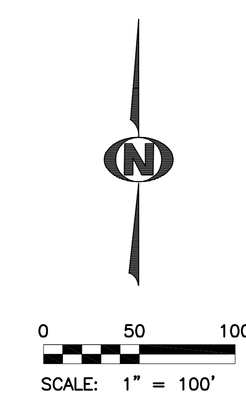
Via e-mail: chad@peakdevgrp.com



VICINITY MAP
NOT TO SCALE

LEGEND:

TH-1 APPROXIMATE LOCATION OF EXPLORATORY BORING



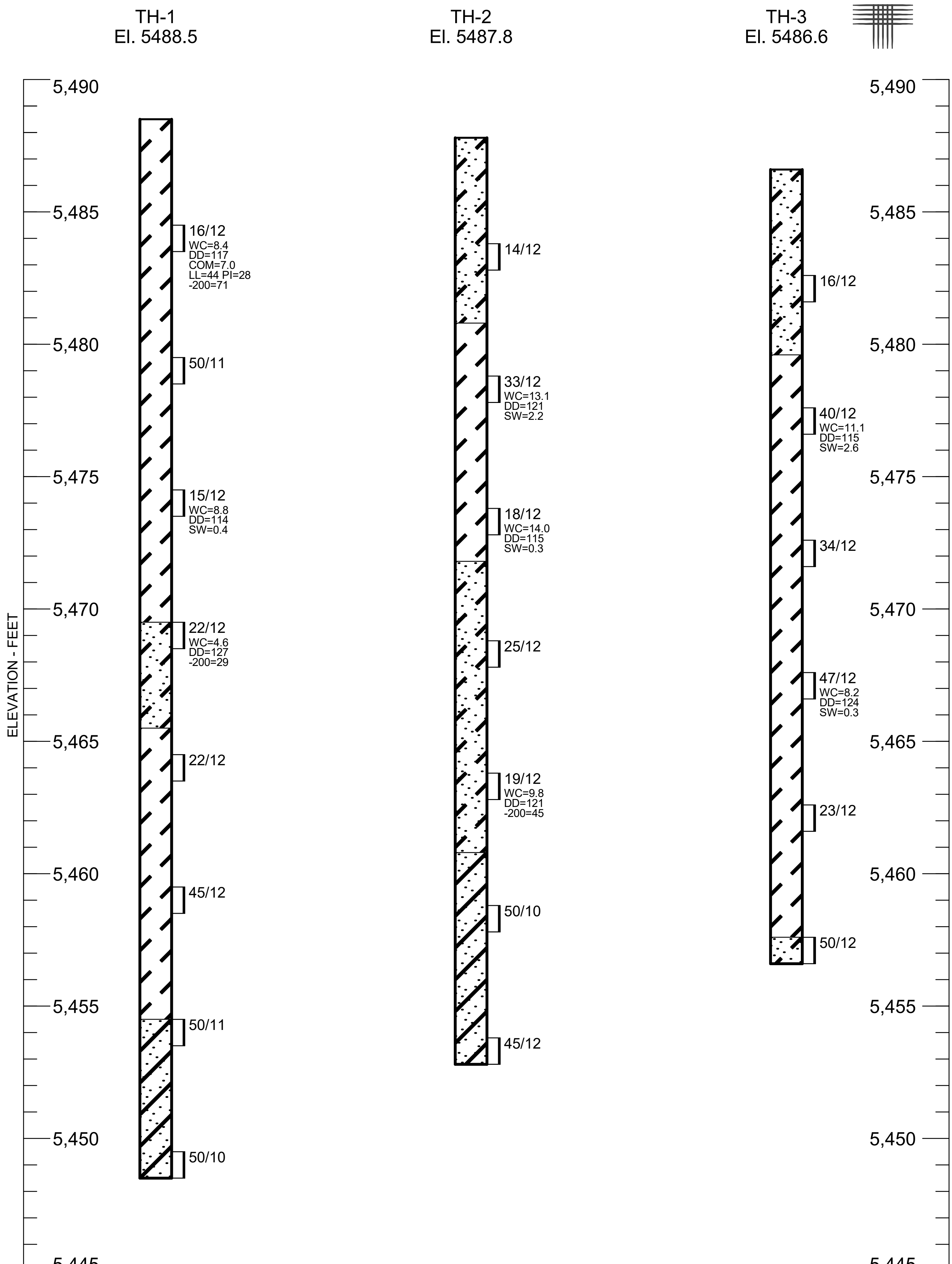
PEAK DEVELOPMENT
SOUTHWEST OF KIOWA STREET AND CUSTER STREET
CTL|T Project No. DN50,554-115-R1

Locations of Exploratory Borings

Fig. 1

APPENDIX A

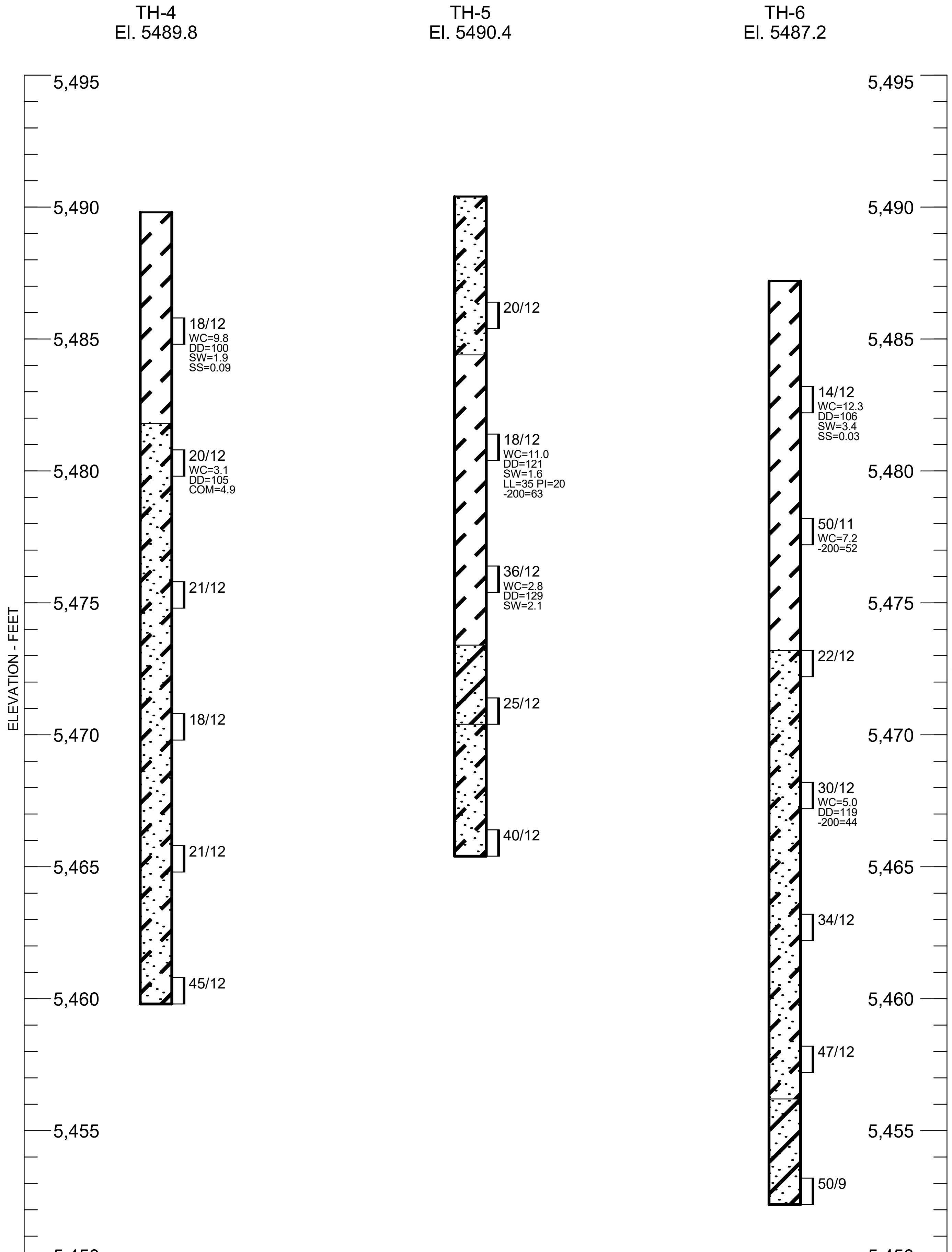
SUMMARY LOGS OF EXPLORATORY BORINGS



SUMMARY LOGS OF EXPLORATORY BORINGS

PEAK DEVELOPMENT
SOUTHWEST OF KIOWA STREET AND CUSTER STREET
CTL|T PROJECT NO. DN50,554-115-R1

FIG. A- 1



SUMMARY LOGS OF EXPLORATORY BORINGS

PEAK DEVELOPMENT
SOUTHWEST OF KIOWA STREET AND CUSTER STREET
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LEGEND:

CLAY, SANDY, STIFF TO VERY STIFF, SLIGHTLY MOIST, BROWN, WHITE (CL).

SAND, CLAYEY, MEDIUM DENSE TO DENSE, SLIGHTLY MOIST, BROWN, TAN (SC).

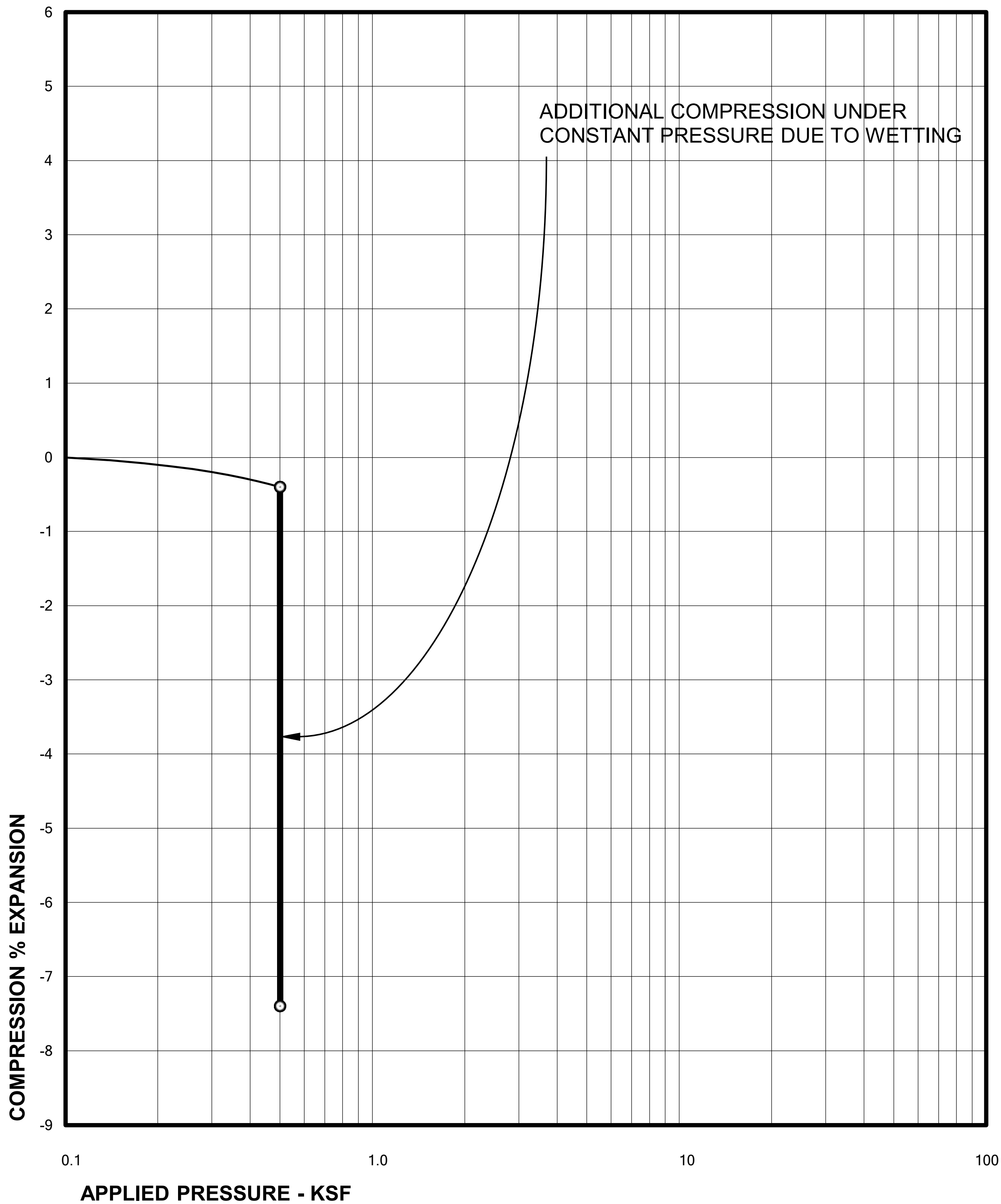
SAND, SILTY, MEDIUM DENSE TO VERY DENSE, MOIST, BROWN (SM).

DRIVE SAMPLE. THE SYMBOL 16/12 INDICATES 16 BLOWS OF AN AUTOMATIC 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE A 2.5-INCH O.D. SAMPLER 12 INCHES.

NOTES:

1. THE BORINGS WERE DRILLED ON JUNE 10, 2020 USING 4-INCH DIAMETER, CONTINUOUS-FLIGHT SOLID-STEM AUGER AND TRUCK-MOUNTED CME-45 DRILL RIG.
2. BORING LOCATIONS AND ELEVATIONS ARE APPROXIMATE AND WERE SURVEYED BY A REPRESENTATIVE OF OUR FIRM USING A LEICA GS18 GPS UNIT REFERENCING THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).
3. GROUNDWATER WAS NOT ENCOUNTERED DURING THIS INVESTIGATION.
4. WC - INDICATES MOISTURE CONTENT (%).
   DD - INDICATES DRY DENSITY (PCF).
   SW - INDICATES SWELL WHEN WETTED UNDER APPLIED PRESSURE (%).
   COM- INDICATES COMPRESSION WHEN WETTED UNDER APPLIED PRESSURE (%).
   LL - INDICATES LIQUID LIMIT.
   PI - INDICATES PLASTICITY INDEX.
   -200 - INDICATES PASSING NO. 200 SIEVE (%).
   SS - INDICATES WATER-SOLUBLE SULFATE CONTENT (%).
5. THESE LOGS ARE SUBJECT TO THE EXPLANATIONS, LIMITATIONS AND CONCLUSIONS CONTAINED IN THIS REPORT.

APPENDIX B
LABORATORY TEST RESULTS



Sample of CLAY, SANDY (CL)

From TH-1 AT 4 FEET

DRY UNIT WEIGHT= 117 PCF

MOISTURE CONTENT= 8.4 %

PEAK DEVELOPMENT
SOUTHWEST OF KIOWA STREET AND CUSTER STREET
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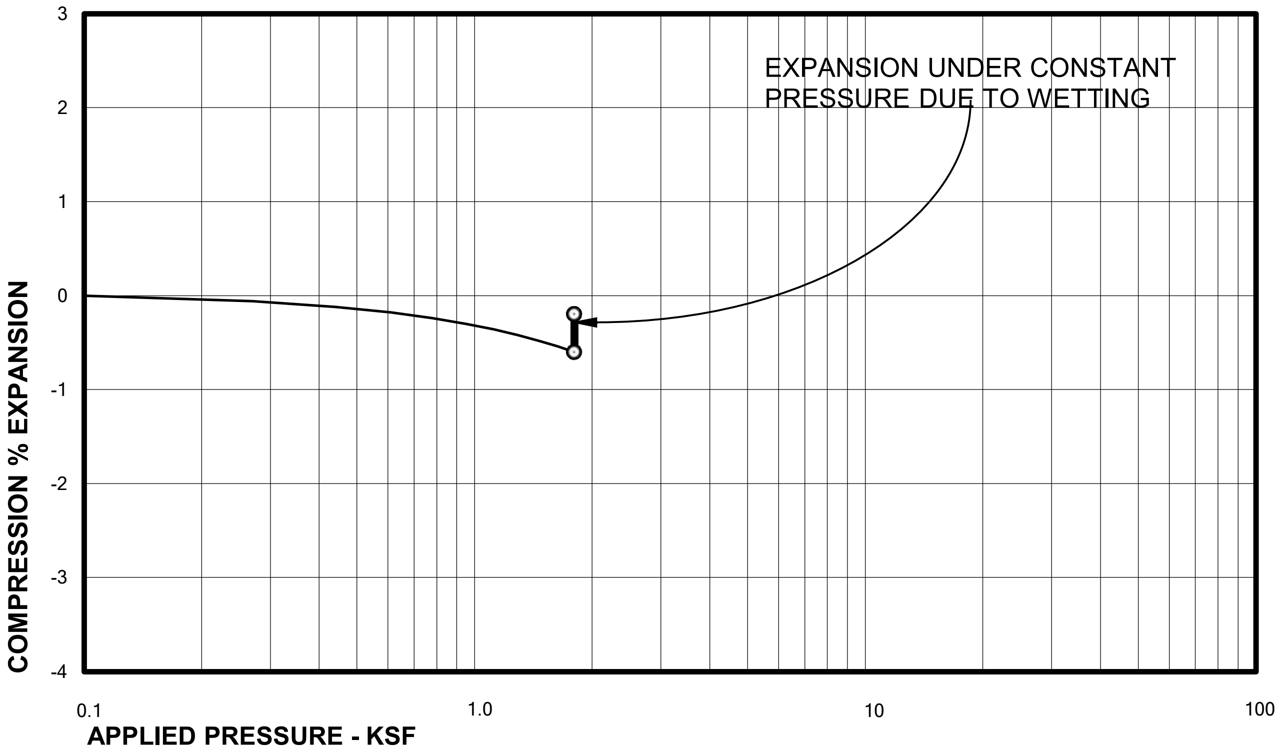
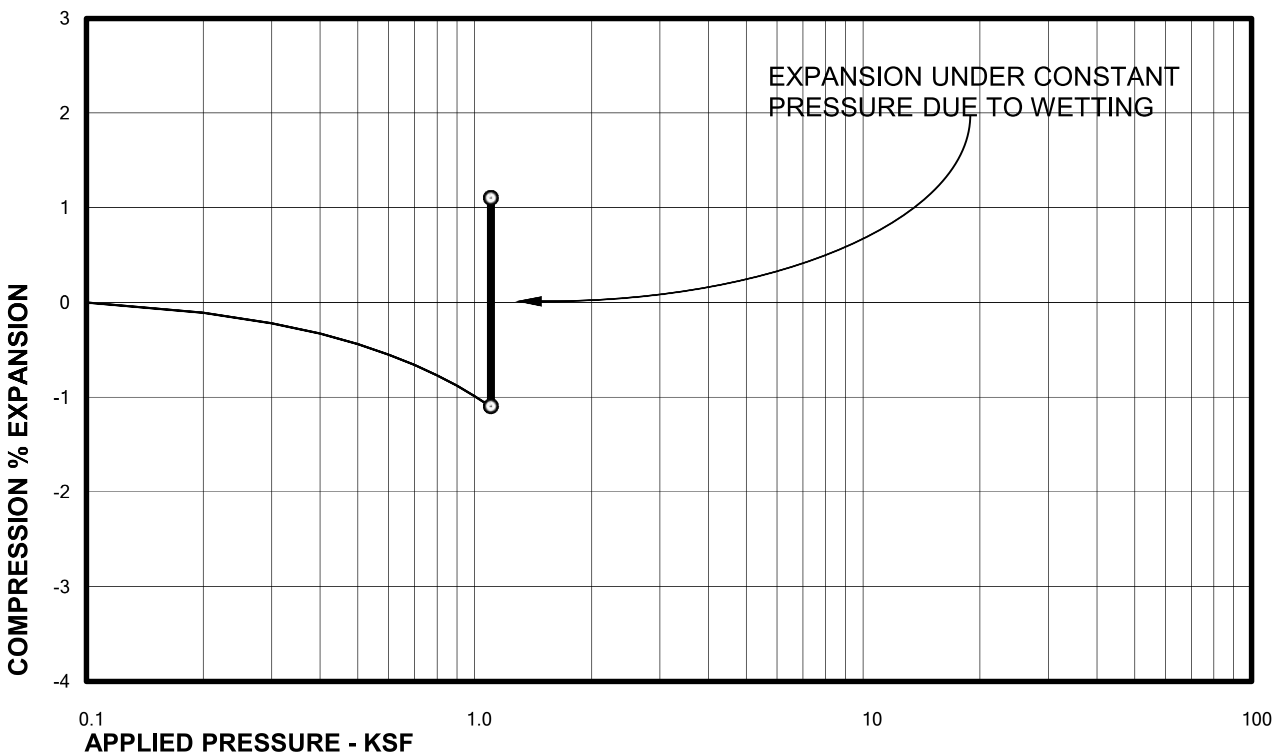
Swell Consolidation Test Results

FIG. B-1



Sample of	CLAY, SANDY (CL)	DRY UNIT WEIGHT=	114	PCF
From	TH-1 AT 14 FEET	MOISTURE CONTENT=	8.8	%



Sample of	CLAY, SANDY (CL)	DRY UNIT WEIGHT=	121	PCF
From	TH-2 AT 9 FEET	MOISTURE CONTENT=	13.1	%

PEAK DEVELOPMENT
SOUTHWEST OF KIOWA STREET AND CUSTER STREET
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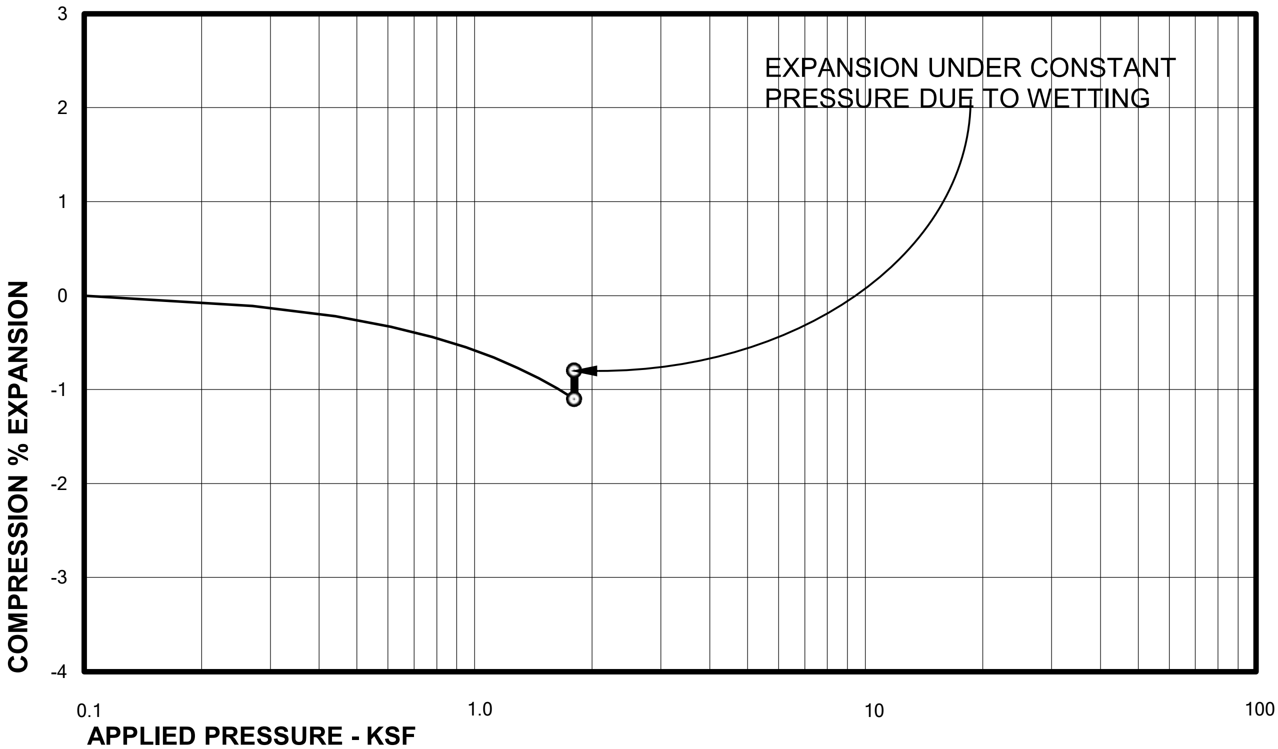
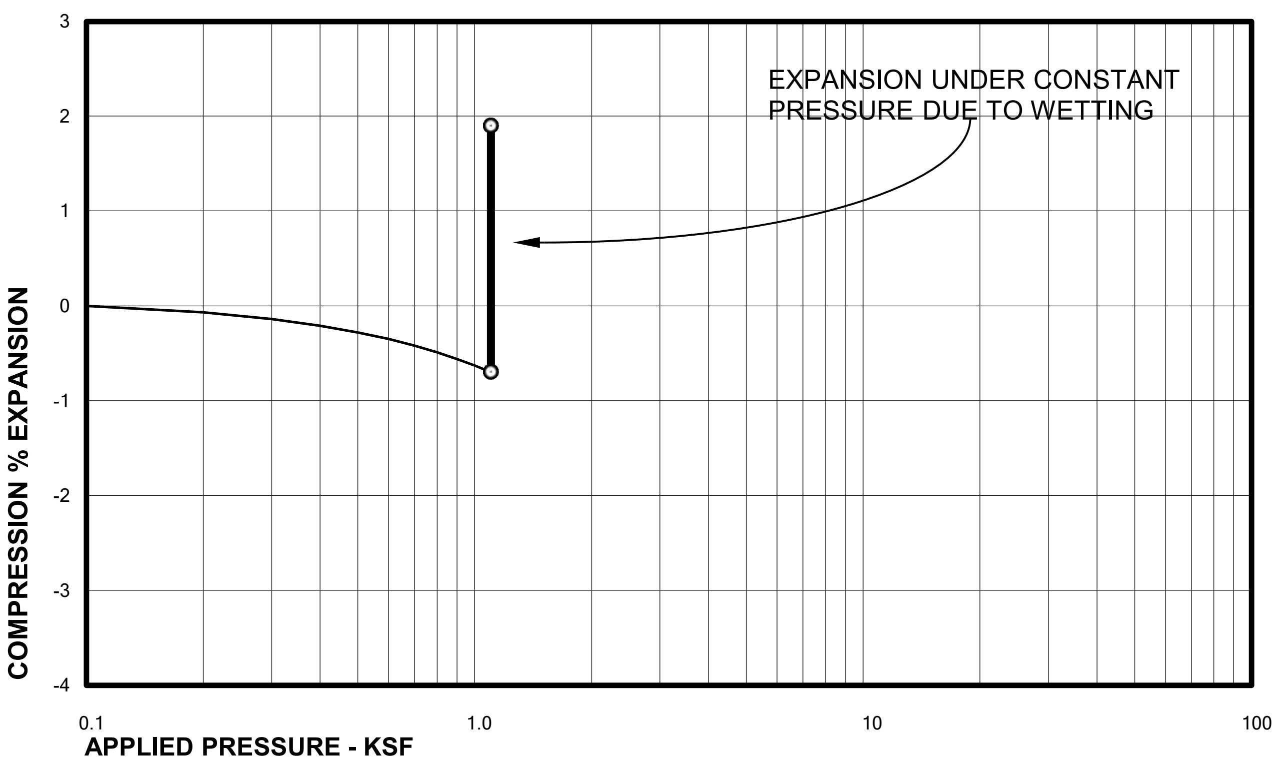
Swell Consolidation Test Results

FIG. B-2



Sample of	CLAY, SANDY (CL)	DRY UNIT WEIGHT=	115	PCF
From	TH-2 AT 14 FEET	MOISTURE CONTENT=	14.0	%



Sample of	CLAY, SANDY (CL)	DRY UNIT WEIGHT=	115	PCF
From	TH-3 AT 9 FEET	MOISTURE CONTENT=	11.1	%

PEAK DEVELOPMENT
SOUTHWEST OF KIOWA STREET AND CUSTER STREET
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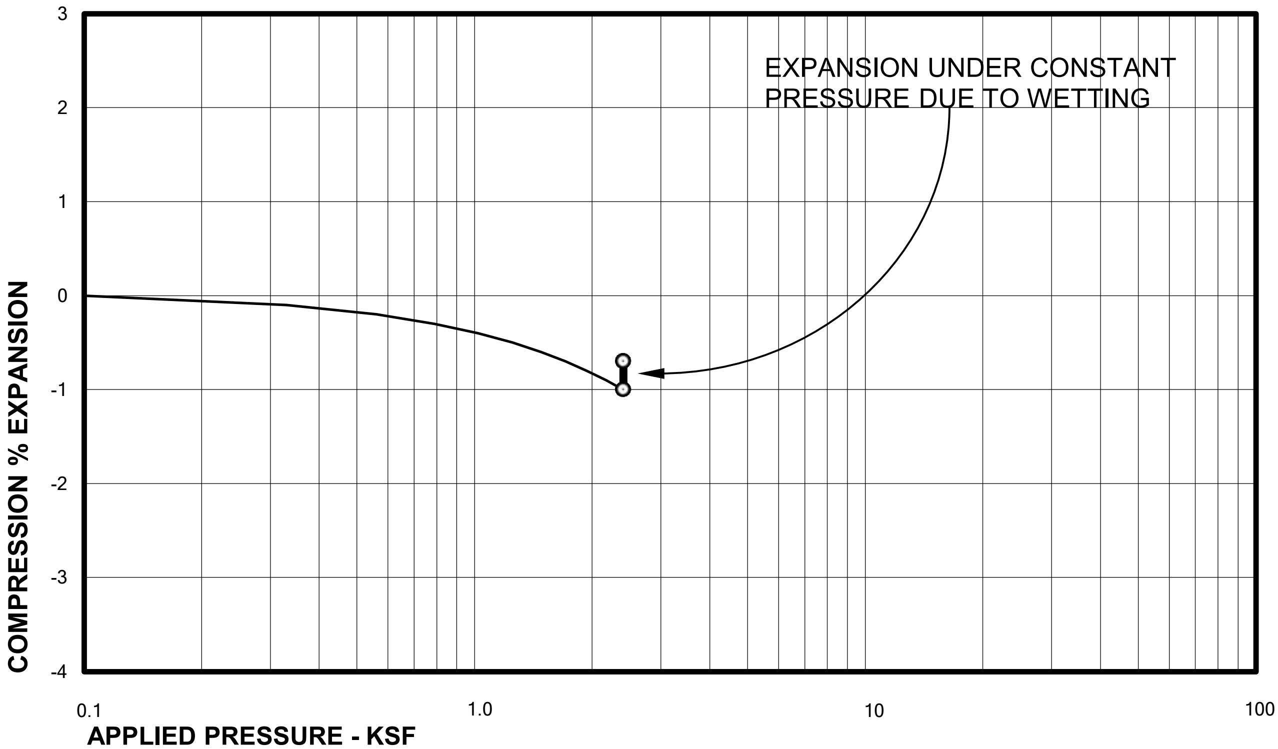
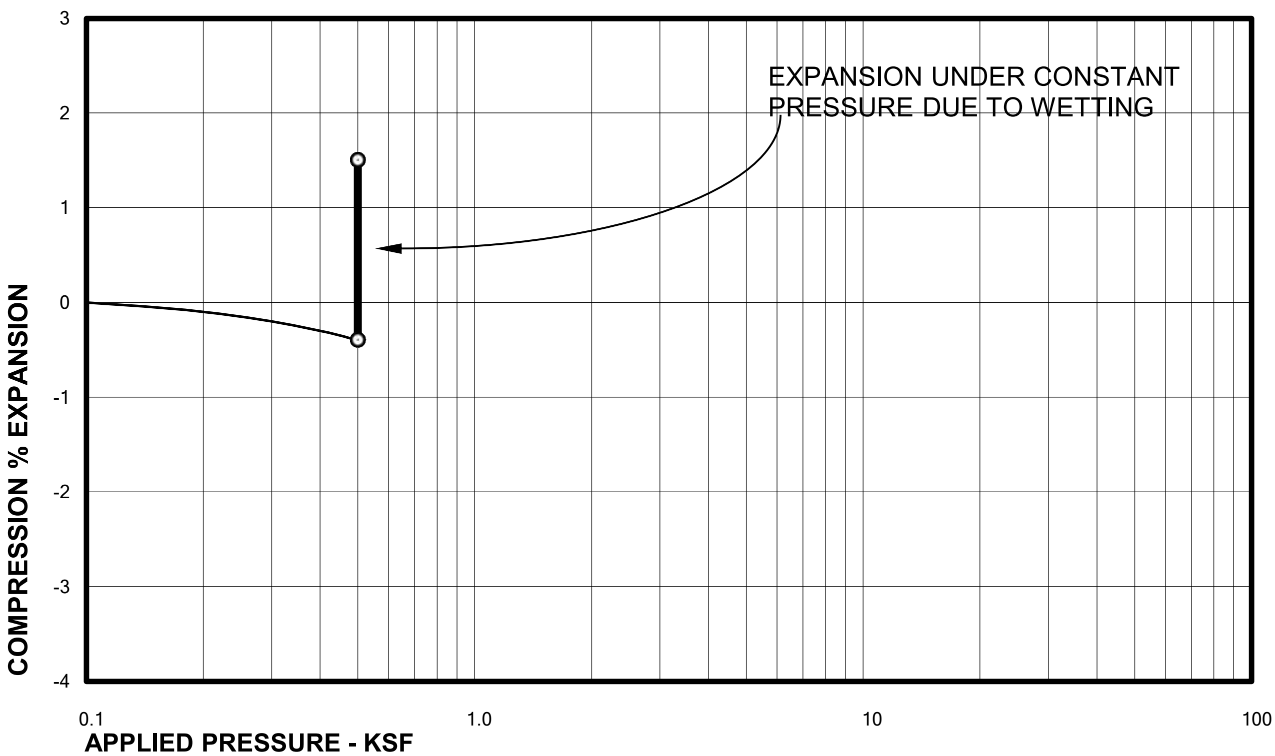
Swell Consolidation Test Results

FIG. B-3



Sample of	CLAY, SANDY (CL)	DRY UNIT WEIGHT=	124	PCF
From	TH-3 AT 19 FEET	MOISTURE CONTENT=	8.2	%



Sample of	CLAY, SANDY (CL)	DRY UNIT WEIGHT=	100	PCF
From	TH-4 AT 4 FEET	MOISTURE CONTENT=	9.8	%

PEAK DEVELOPMENT
SOUTHWEST OF KIOWA STREET AND CUSTER STREET
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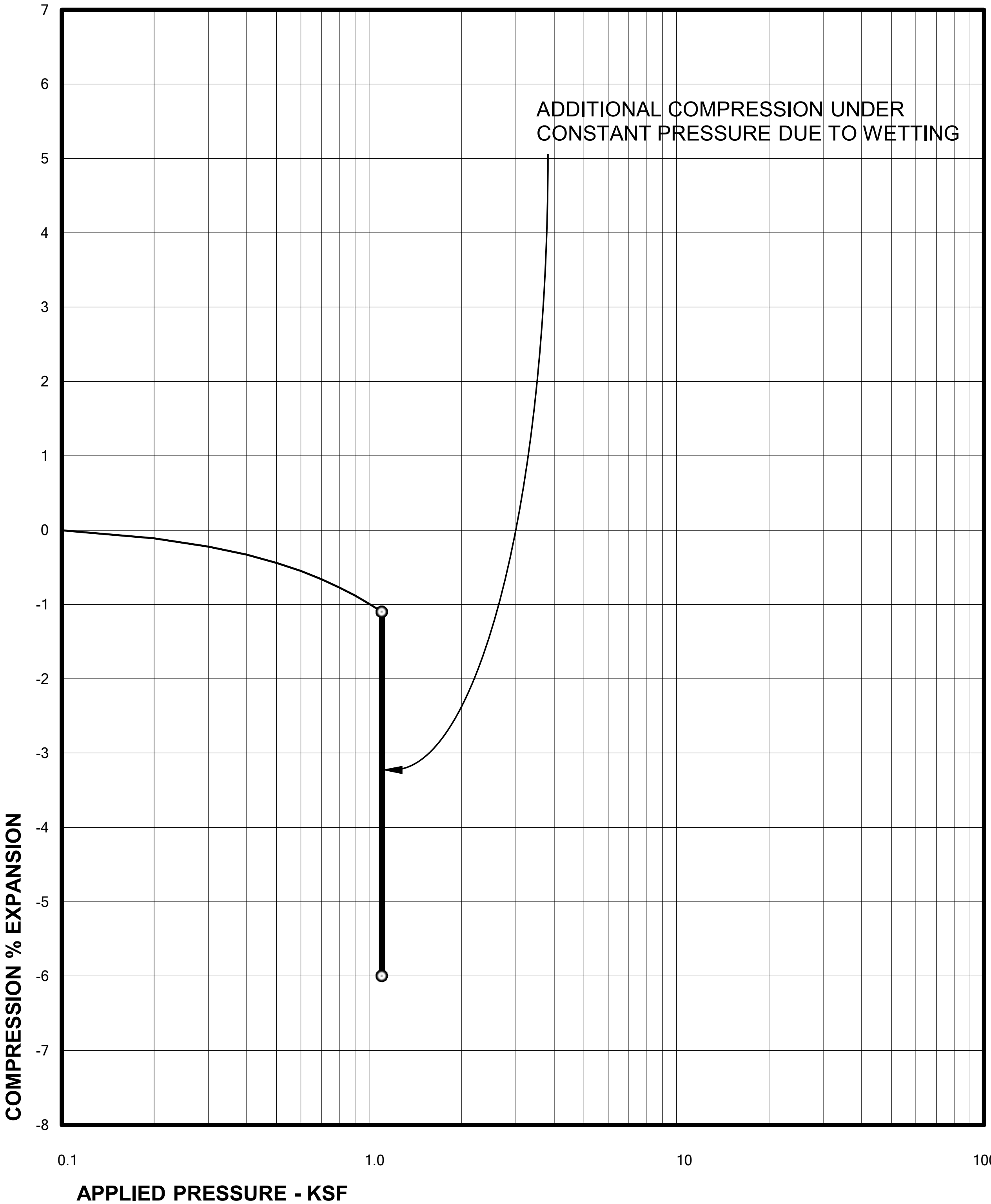
Swell Consolidation Test Results

FIG. B-4



Sample of	SAND, CLAYEY (SC)	DRY UNIT WEIGHT=	105	PCF
From	TH-4 AT 9 FEET	MOISTURE CONTENT=	3.1	%

PEAK DEVELOPMENT
SOUTHWEST OF KIOWA STREET AND CUSTER STREET
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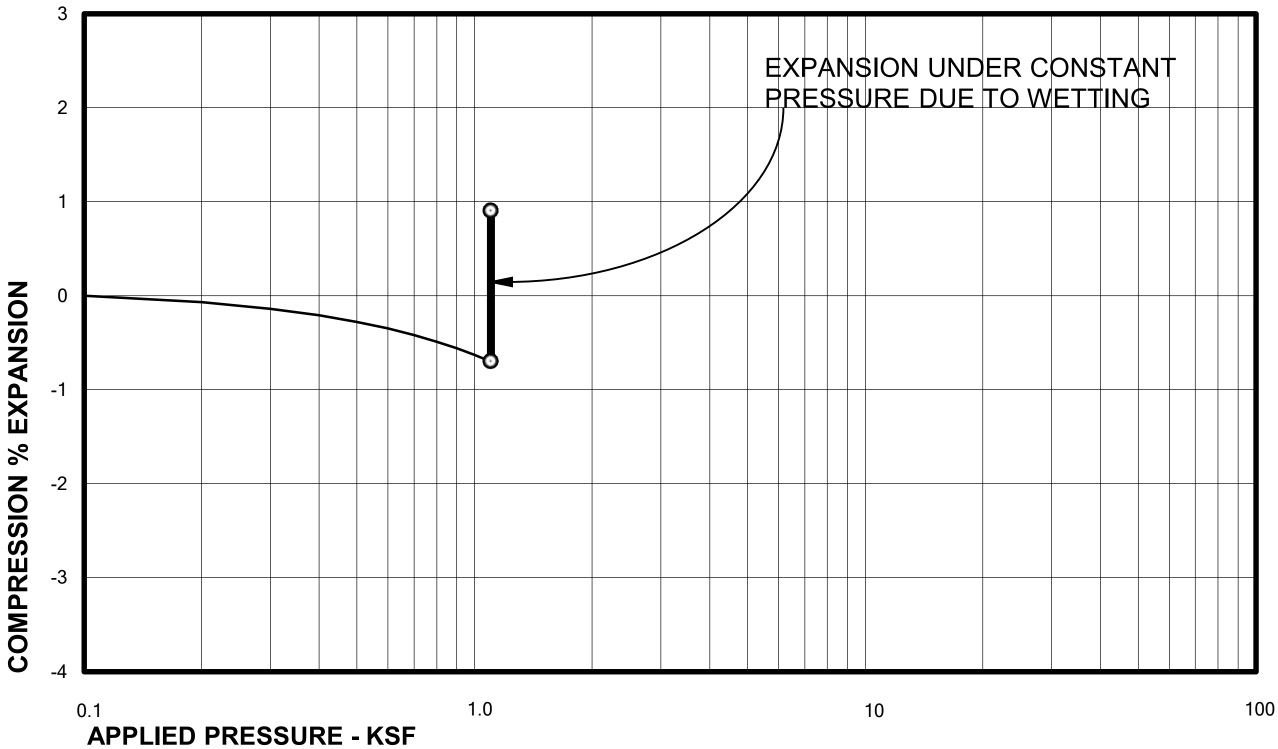
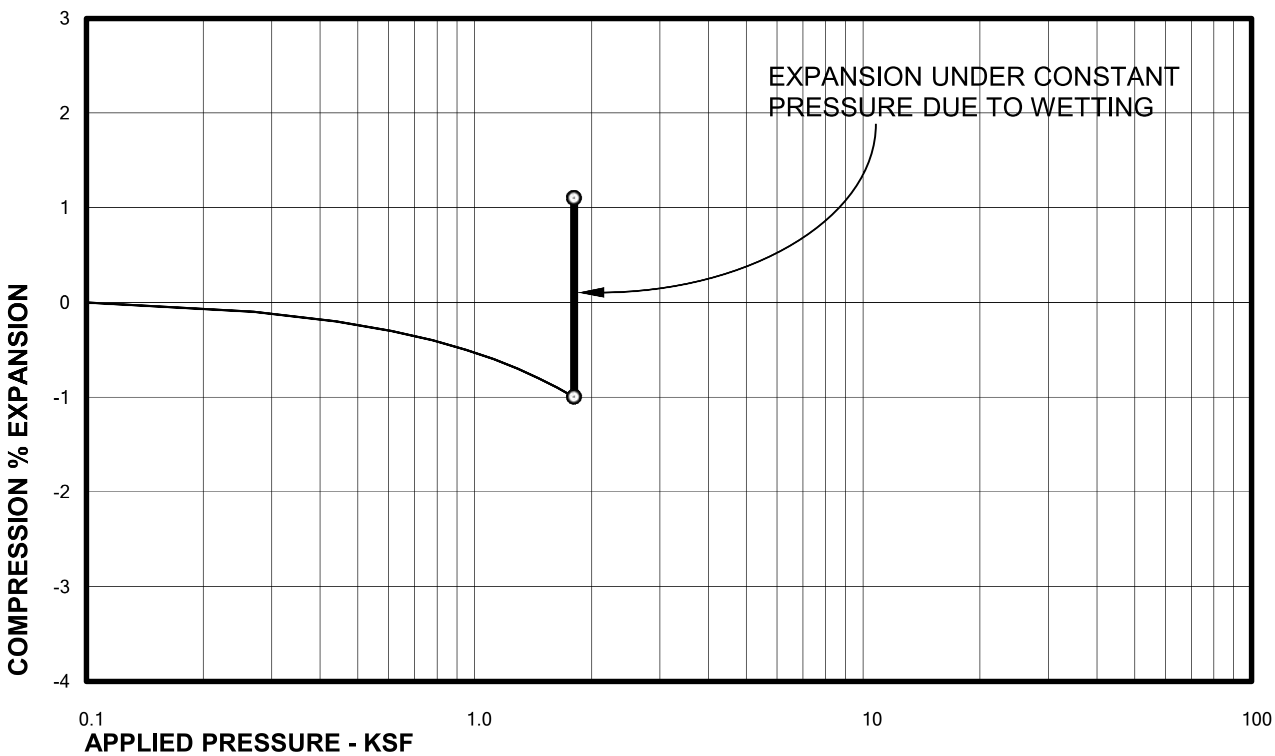
Swell Consolidation Test Results

FIG. B-5



Sample of CLAY, SANDY (CL)
From TH-5 AT 9 FEET

DRY UNIT WEIGHT= 121 PCF
MOISTURE CONTENT= 11.0 %



Sample of CLAY, SANDY (CL)
From TH-5 AT 14 FEET

DRY UNIT WEIGHT= 129 PCF
MOISTURE CONTENT= 2.8 %

PEAK DEVELOPMENT
SOUTHWEST OF KIOWA STREET AND CUSTER STREET
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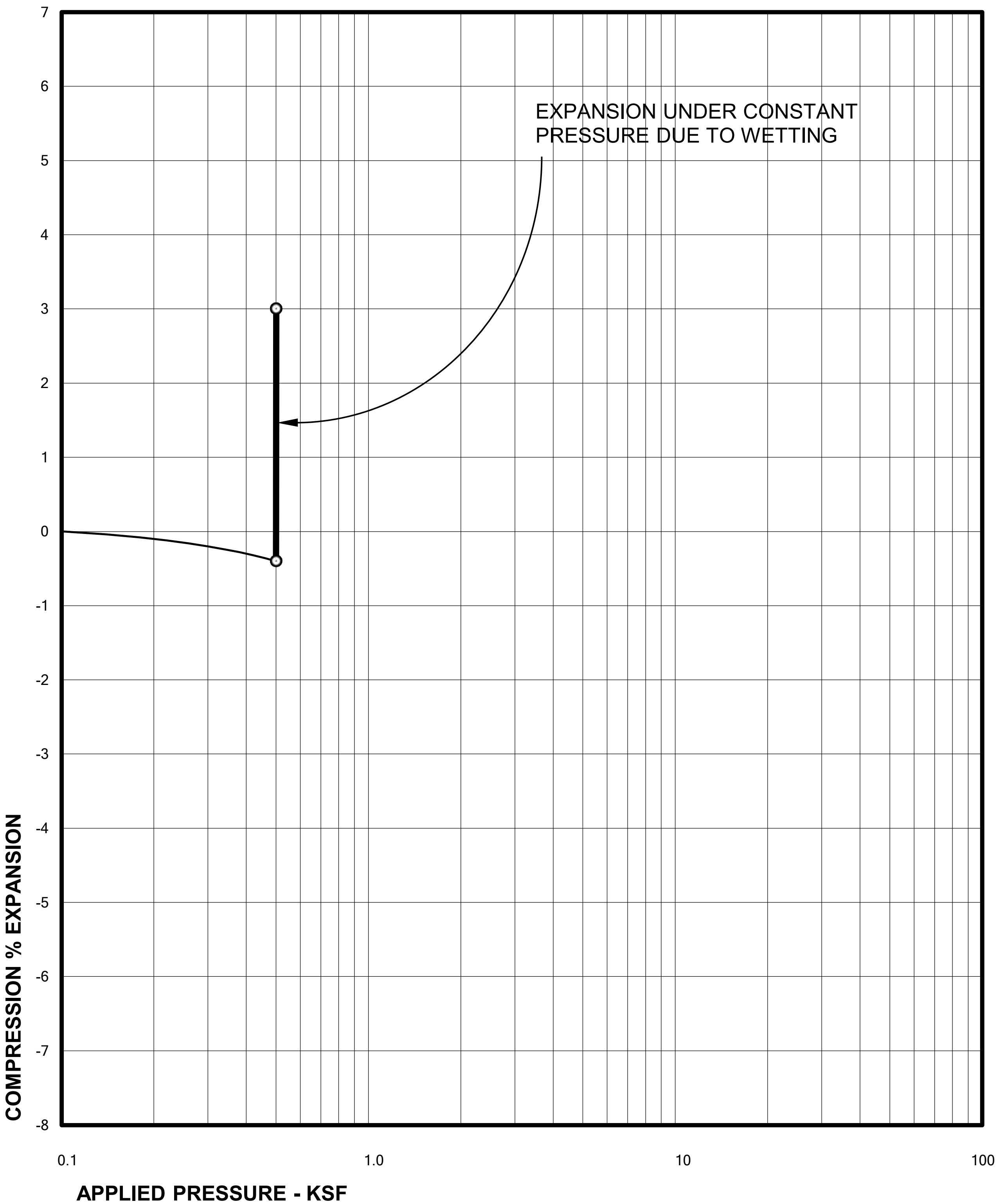
Swell Consolidation Test Results

FIG. B-6



Sample of	CLAY, SANDY (CL)		DRY UNIT WEIGHT=	106	PCF
From	TH-6 AT 4 FEET		MOISTURE CONTENT=	12.3	%

PEAK DEVELOPMENT
SOUTHWEST OF KIOWA STREET AND CUSTER STREET
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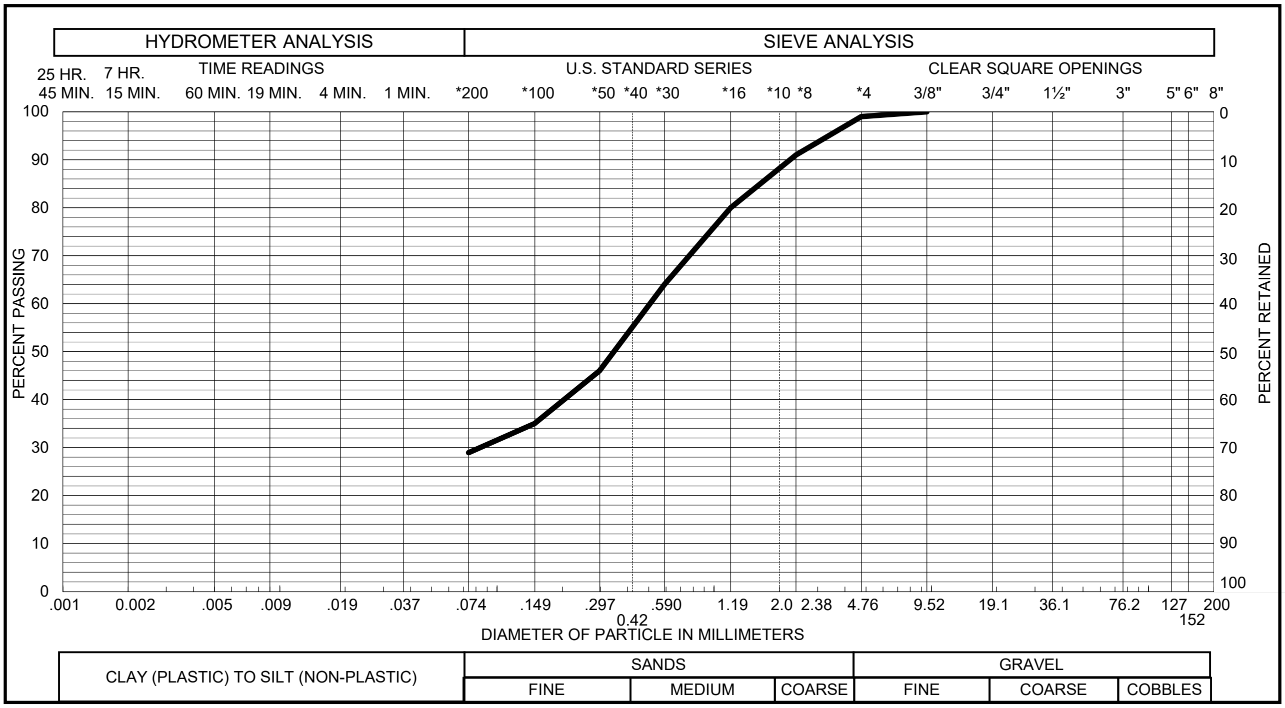
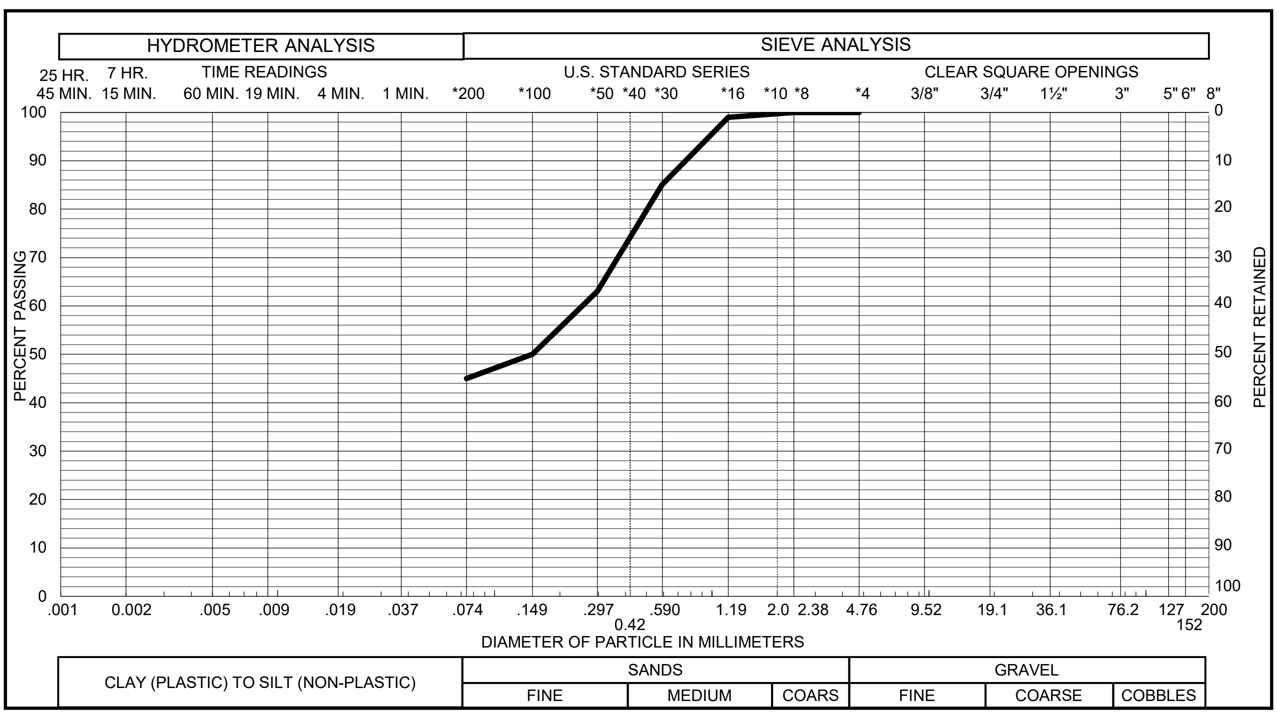
Swell Consolidation Test Results

FIG. B-7



Sample of SAND, CLAYEY (SC)
From TH - 1 AT 19 FEET

GRAVEL 1 % SAND 70 %
SILT & CLAY 29 % LIQUID LIMIT
PLASTICITY INDEX



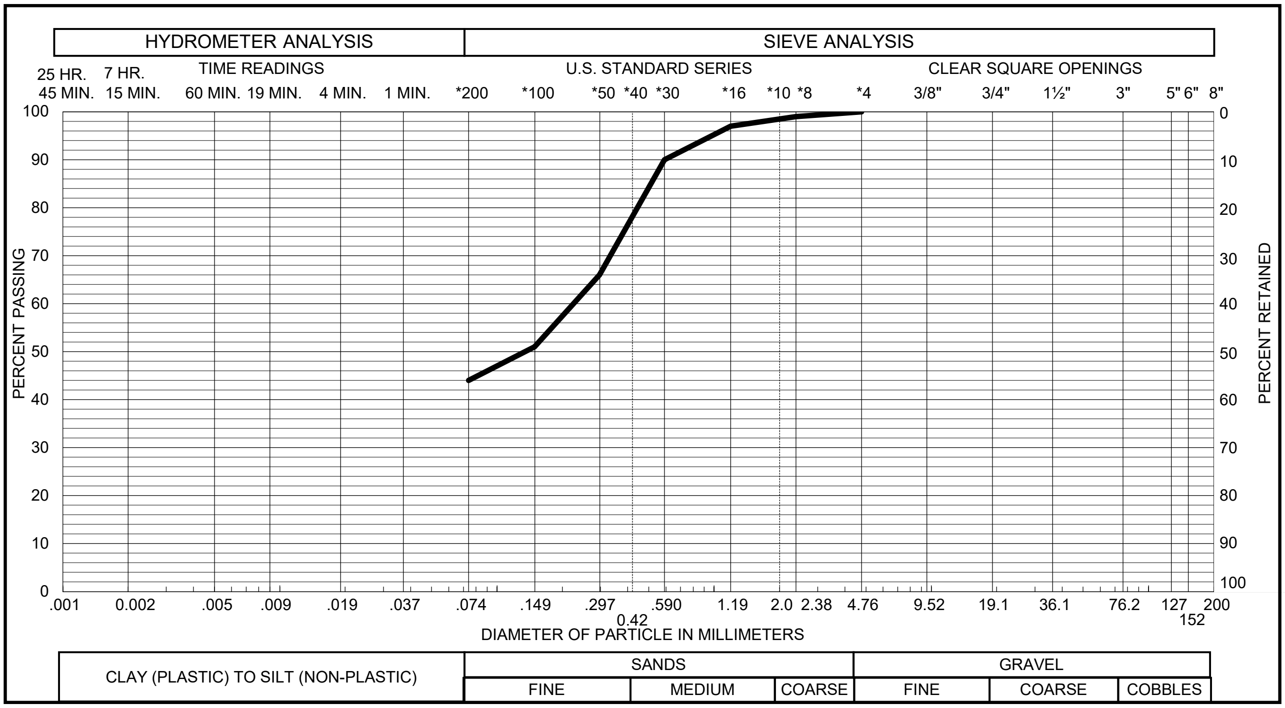
Sample of SAND, CLAYEY (SC)
From TH - 2 AT 24 FEET

GRAVEL 0 % SAND 55 %
SILT & CLAY 45 % LIQUID LIMIT
PLASTICITY INDEX

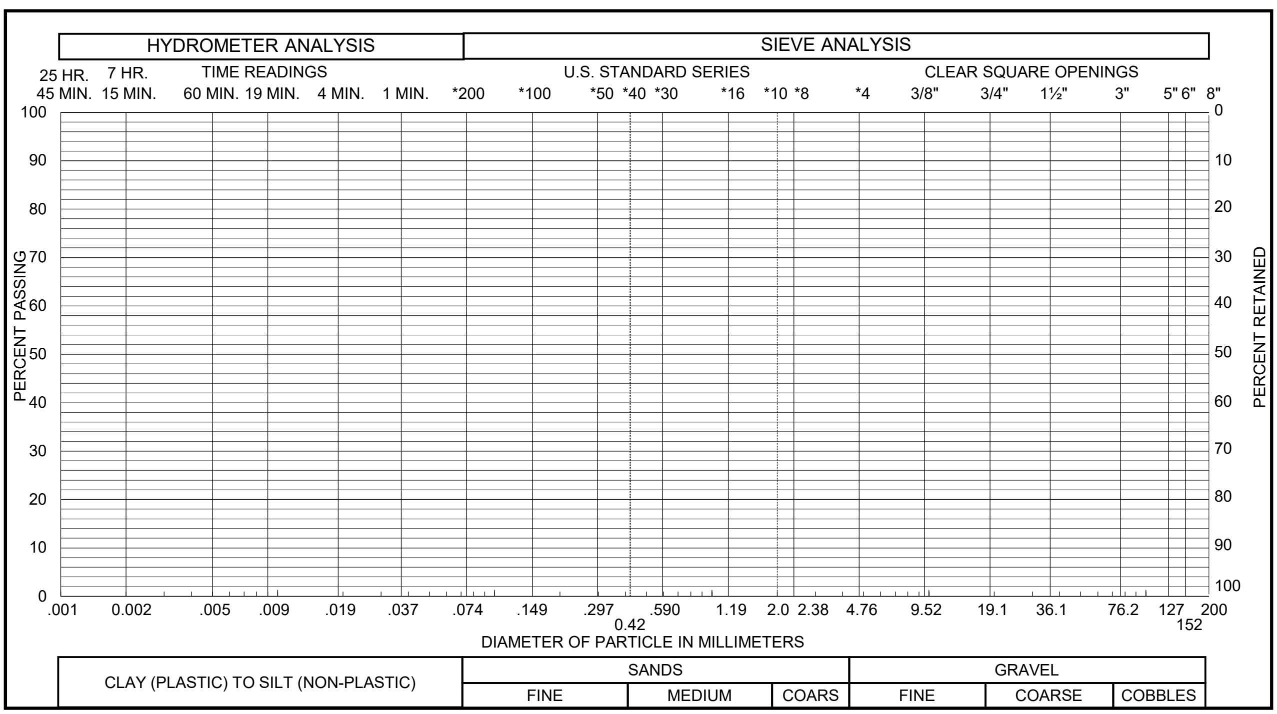
Gradation Test Results

FIG. B-8

PEAK DEVELOPMENT
SOUTHWEST OF KIOWA STREET AND CUSTER STREET
CTL|T PROJECT NO. DN50,554-115-R1



Sample of	SAND, CLAYEY (SC)	GRAVEL 0 %	SAND	56 %
From	TH - 6 AT 19 FEET	SILT & CLAY 44 %	LIQUID LIMIT	
		PLASTICITY INDEX		



Sample of		GRAVEL %	SAND	%
From		SILT & CLAY %	LIQUID LIMIT	
		PLASTICITY INDEX		

Gradation Test Results

FIG. B-9

PEAK DEVELOPMENT
SOUTHWEST OF KIOWA STREET AND CUSTER STREET
CTL|T PROJECT NO. DN50,554-115-R1

TABLE B - I

SUMMARY OF LABORATORY TEST RESULTS

BORING	DEPTH (ft)	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	SWELL TEST DATA SWELL (%)	COMPRESSION (%)	APPLIED PRESSURE (psf)	ATTERBERG LIMITS LIQUID LIMIT	PLASTICITY INDEX	SOLUBLE SULFATE CONTENT (%)	PASSING NO. 200 SIEVE (%)	SOIL TYPE
TH-1	4	8.4	117		7.0	500	44	28		71	CLAY, SANDY (CL)
TH-1	14	8.8	114	0.4		1,800					CLAY, SANDY (CL)
TH-1	19	4.6	127							29	SAND, CLAYEY (SC)
TH-2	9	13.1	121	2.2		1,100					CLAY, SANDY (CL)
TH-2	14	14.0	115	0.3		1,800					CLAY, SANDY (CL)
TH-2	24	9.8	121							45	SAND, CLAYEY (SC)
TH-3	9	11.1	115	2.6		1,100					CLAY, SANDY (CL)
TH-3	19	8.2	124	0.3		2,400					CLAY, SANDY (CL)
TH-4	4	9.8	100	1.9		500			0.09		CLAY, SANDY (CL)
TH-4	9	3.1	105		4.9	1,100					SAND, CLAYEY (SC)
TH-5	9	11.0	121	1.6		1,100	35	20		63	CLAY, SANDY (CL)
TH-5	14	2.8	129	2.1		1,800					CLAY, SANDY (CL)
TH-6	4	12.3	106	3.4		500			0.03		CLAY, SANDY (CL)
TH-6	9	7.2								52	CLAY, SANDY (CL)
TH-6	19	5.0	119							44	SAND, CLAYEY (SC)

APPENDIX C

GUIDELINE SITE GRADING AND SUB-EXCAVATION SPECIFICATIONS

GUIDELINE SITE GRADING SPECIFICATIONS

21-Acre Parcel
Southwest of Kiowa Street and Custer Street
Bennett, Colorado

1. DESCRIPTION

This item shall consist of the excavation, transportation, placement and compaction of materials from locations indicated on the plans, or staked by the Engineer, as necessary to achieve rough street and overlot elevations. These specifications shall also apply to compaction of excess cut materials that may be placed outside of the project.

The Soils Representative may call for the removal or sub-excavation of expansive or otherwise unacceptable soil or bedrock materials in structure or pavement areas. Usually, these materials will be replaced with either approved site or imported soils. Often, the removed soil can be re-used and treated to reduce swell potential by excavating, thoroughly mixing, increasing the moisture content and compaction to comply with this specification.

2. GENERAL

The Soils Representative shall be the Owner's representative. The Soils Representative shall approve fill materials, method of placement, moisture contents and percent compaction, and shall give written approval of the completed fill.

3. CLEARING JOB SITE

The Contractor shall remove all trees, brush and rubbish before excavation or fill placement begins. The Contractor shall dispose of the cleared material to provide the Owner with a clean, neat appearing job site. Cleared material shall not be placed in areas to receive fill or where the material will support structures of any kind.

4. SCARIFYING AREA TO BE FILLED

All topsoil and vegetable matter shall be removed from the ground surface upon which fill is to be placed. The surface shall then be plowed or scarified, moisture treated to between optimum and 3 percent above optimum moisture content and graded until the surface is free from ruts, hummocks or other uneven features, which would prevent uniform compaction by the equipment to be used.

5. COMPACTING AREA TO BE FILLED

After the foundation for the fill has been cleared and scarified, it shall be disked or bladed until it is free from large clods, brought to the proper moisture content (optimum to 3 percent above optimum) and compacted to not less than 95 percent of maximum density as determined in accordance with ASTM D 698. The foundation materials shall be reworked, stabilized, or removed and recompacted and replaced, if necessary, in accordance with the Soil Representative’s recommendations in preparation for fill.

6. FILL MATERIALS

Fill soils shall be free from vegetable matter or other deleterious substances, and shall not contain rocks having a diameter greater than six (6) inches or claystone pieces larger than 3 inches. Fill materials shall be obtained from cut areas shown on the plans or staked in the field by the Engineer or imported to the site. Concrete, asphalt, organic matter and other deleterious materials or debris shall not be used as fill. On-site materials classifying as CH, CL, SC, SM, SW, SP, GP, GC and GM and import materials classifying as SC, SM, GC and GM are acceptable.

7. MOISTURE CONTENT

Fill material shall be moisture treated to within limits of optimum moisture content specified in “Moisture Content and Density Criteria.” Sufficient laboratory compaction tests shall be made to determine the optimum moisture content for the various soils encountered in borrow areas or imported to the site.

The Contractor may be required to add moisture to the excavation materials in the borrow area if, in the opinion of the Soils Representative, it is not possible to obtain uniform moisture content by adding water on the fill surface. The Contractor may be required to rake or disc the fill soils to provide uniform moisture content through the soils.

The application of water to embankment materials shall be made with any type of watering equipment approved by the Soils Representative, which will give the desired results. Water jets from the spreader shall not be directed at the embankment with such force that fill materials are washed out.

Should too much water be added to any part of the fill, such that the material is too wet to permit the desired compaction from being obtained, rolling and all work on that section of the fill shall be delayed until the material has been allowed to dry to the required moisture content. The Contractor will be permitted to rework wet material in an approved manner to hasten its drying.

8. COMPACTION OF FILL AREAS

Selected fill material shall be placed and mixed in evenly spread layers. After each fill layer has been placed, it shall be uniformly compacted to not less than the specified percentage of maximum density given in “Moisture Content and Density Criteria.” Fill materials shall be placed such that the thickness of loose materials does not exceed 8 inches and the compacted lift thickness does not exceed 6 inches.

Compaction as specified above, shall be obtained by the use of sheepsfoot rollers, multiple-wheel pneumatic-tired rollers, or other equipment approved by the Engineer for soils classifying as CH, CL or SC. Granular fill shall be compacted using vibratory equipment or other equipment approved by the Soils Representative. Compaction shall be accomplished while the fill material is at the specified moisture content. Compaction of each layer shall be continuous over the entire area. Compaction equipment shall make sufficient trips to ensure that the required density is obtained.

9. <u>MOISTURE CONTENT AND DENSITY CRITERIA</u>

Fill material shall be substantially compacted to at least 95 percent of maximum ASTM D 698 (AASHTO T 99) dry density at optimum to 3 percent above optimum moisture content for on-site clays (within 2 percent of optimum for granular soils).

10. <u>COMPACTION OF SLOPES</u>

Fill slopes shall be compacted by means of sheepsfoot rollers or other suitable equipment. Compaction operations shall be continued until slopes are stable, but not too dense for planting, and there is not appreciable amount of loose soils on the slopes. Compaction of slopes may be done progressively in increments of three to five feet (3' to 5') in height or after the fill is brought to its total height. Permanent fill slopes shall not exceed 3:1 (horizontal to vertical).

11. <u>DENSITY TESTS</u>

Field density tests shall be made by the Soils Representative at locations and depths of his choosing. Where sheepsfoot rollers are used, the soil may be disturbed to a depth of several inches. Density tests shall be taken in compacted material below the disturbed surface. When density tests indicate that the density or moisture content of any layer of fill or portion thereof is below that required, the particular layer or portion shall be reworked until the required density or moisture content has been achieved.

12. <u>INSPECTION AND TESTING OF FILL</u>

Inspection by the Soils Representative shall be full time during the placement of fill and compaction operations so they can declare the fill was placed in general conformance with specifications. All inspections necessary to test the placement of fill and observe compaction operations will be at the expense of the owner.

13. <u>SEASONAL LIMITS</u>

No fill material shall be placed, spread or rolled while it is frozen, thawing, or during unfavorable weather conditions. When work is interrupted by heavy precipitation, fill operations shall not be resumed until the Soils Representative indicates that the moisture content and density of previously placed materials are as specified.

14. <u>NOTICE REGARDING START OF GRADING</u>

The Contractor shall submit notification to the Soils Representative and Owner advising them of the start of grading operations at least three (7) days in advance of the starting date. Notification shall also be submitted at least three (3) days in advance of any resumption dates when grading operations have been stopped for any reason other than adverse weather conditions.

15. REPORTING OF FIELD DENSITY TESTS

Density tests made by the Soils Representative, as specified under "Density Tests" above, shall be submitted progressively to the Owner. Dry density, moisture content, and percentage compaction shall be reported for each test taken.

16. DECLARATION REGARDING COMPLETED FILL

The Soils Representative shall provide a written declaration stating whether the site was filled with acceptable materials, and was placed in general accordance with the specifications.